REMARKS

Status of the Claims

Claims 1-10 are pending, with claims 1 and 8 being independent. Claims 1-4 and 7-10 have been amended. No new matter has been added.

Applicants respectfully request the Examiner to reconsider and withdraw the outstanding rejections in view of the foregoing amendments and following remarks.

Specification

The specification has been amended to correct a misspelling of the word "identifiers" at Page 15, Line 10.

Claim Interpretation

Claim 1 has been amended to recite that the number N of materials tracked is at least 2, and to recite that "whether voids and overlaps are present is calculated using a product of the unique identifiers."

Claim Rejections Under 35 U.S.C. § 101

Claims 1-10 stand rejected under 35 U.S.C. § 101 because the claimed invention is allegedly directed to non-statutory subject matter. The Examiner asserts that the method claims do not produce a useful, tangible, and concrete result. Applicants respectfully disagree with the rejection; therefore, this rejection is respectfully traversed.

The relevant question is whether the claimed invention produces a useful, concrete and tangible result, *i.e.*, whether it accomplishes a practical application. *See* MPEP § 2106; *State Street Bank & Trust Co. v. Signature Financial Group Inc.*, 149 F. 3d 1368, 1373, 47 USPQ2d 1596, 1601-02 (Fed. Cir. 1998). Applicants respectfully submit that the present claims, consistent with the Interim Guidelines for Subject Matter Eligibility set forth in the Official Gazette of November 22, 2005, do produce useful, concrete and tangible results.

In particular, a simulation of flow of N materials and their interfaces in a computational domain is created according to claim 1, and a determination of whether cells overlap and voids are present in a grid of a fluid dynamics computation is calculated according to claim 8. Accordingly, withdrawal of the rejection under 35 U.S.C. § 101 is respectfully requested.

Claim Rejections Under 35 U.S.C. § 112

Claims 1-10 stand rejected under 35 U.S.C. § 112, first paragraph, as allegedly failing to comply with the enablement requirement. Claims 1-7 stand rejected under 35 U.S.C. § 112, second paragraph, as allegedly indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Applicants respectfully submit that the amendments to claims 1, 4, 7, 8, and 10 render these rejections under 35 U.S.C. § 112 moot.

Claims 1-10 stand rejected under 35 U.S.C. § 112, second paragraph, as allegedly incomplete for omitting essential steps, such omission amounting to a gap between the steps. In particular, the Examiner asserts, "The missing steps are: establishing a relationship between the unique identifiers with respect to equations of motions [sic]." Applicants respectfully disagree with the rejections; therefore, these rejection are respectfully traversed.

Applicants respectfully submit that there is no relationship between the equations of motion and the unique identifiers. Rather, the equations of motion are solved utilizing the calculated volume fractions to arrive at local velocity conditions, while the unique identifiers are used to calculate whether voids and overlaps are present, as recited in the clause "wherein whether voids and overlaps are present is calculated using a product of the unique identifiers", added to step (g) of claim 1.

Accordingly, withdrawal of the rejection under 35 U.S.C. § 112, second paragraph, is respectfully requested.

Claim Rejections Under 35 U.S.C. § 102

Claims 1, 4, and 8 stand rejected under 35 U.S.C. § 102(b) as allegedly anticipated by Rudman's, "A volume-tracking method for incompressible multifluid flows with large density variations" ("Rudman"). Applicants respectfully disagree with the rejection; therefore, this rejection is respectfully traversed.

Rudman discloses a numerical technique (fine grid volume tracking or FGVT) for solving the time-dependent incompressible Navier-Stokes equations in fluid flows with large density variations for staggered grids. Mass conservation is based on a volume tracking method and incorporates a piecewise-linear interface reconstruction on a grid twice as fine as the velocity-pressure grid. It also uses a special flux-corrected transport algorithm for momentum advection, a multigrid algorithm for solving a pressure-correction equation and a surface tension algorithm that is robust and stable. In principle, the method conserves both mass and momentum exactly, and maintains extremely sharp fluid interfaces. (Summary).

The presently claimed invention relates generally to methods for the simulation of multiphase fluid flows, and more particularly, to those methods which track interfaces between immiscible fluids. (Page 1, Lines 6-8). As explained at page 9, lines 21, of the present specification, during the process of the presently claimed methods, N fluid materials are assigned to each of the microgrid cells. (See Page 9, Lines 9-19). More specifically,

> As a numerical representation of the physical system is created, a single prime number or identifier associated with a particular fluid material is assigned to each microgrid cell. For example, all microgrid cells that contain material N=1 are given the identifier 43. All microgrid cells that contain material N=2 are assigned the identifier 47 and cells containing material N=3 are labeled with the identifier 53. In this way, a prime representation of the system is built.

(Page 9, Lines 24-30). As further explained at page 14, line 26 – page 15, line 11, of the present specification,

> As the advection step begins, an interim array is used to receive advected microgrid cell information. This interim array is initialized to values of "1", and the size of the interim array corresponds to the size of the microgrid cellular field. During the advection step, new microgrid cell values are constructed via a multiplicative association of primes and then stored in the interim array at the appropriate locations. For example, a microgrid cell receiving one copy of a single material (such as material 1) would be represented by 1 x 43 = 43. A microgrid cell receiving 2 different materials may be numerically represented as 1 x 43 x 53 = 2279, which indicates the

> presence of both materials 1 and 3 in the microgrid cell. Similarly, a cell may receive two copies of the same material (e.g. 1 x 43 x 43 = 1849). If no material is advected into an interim array location, then the value remains as "1" and indicates that void is present. . . . Where there is a void, the array contains a numeral "1". Where there is an overlap of microgrid cells, the product of the material identifers (primes) of the overlapping microgrid cells is given.

Accordingly, amended Claim 1 recites a method for creating a simulation of flow of N materials and their interfaces in a computational domain comprising the steps of: (a) creating a macrogrid including control volumes on a computational domain in which N materials and their interfaces are to be tracked, wherein the number N of materials tracked is at least 2; (b) overlaying a microgrid including microgrid cells upon the macrogrid with each of the microgrid cells being coupled to a control volume; (c) initializing the macrogrid and control volumes with initial and boundary conditions; (d) assigning a unique identifier to each of the N materials and to the microgrid cells; (e) calculating volume fractions for the N-materials in the control volumes; (f) solving equations of motion upon the macrogrid and control volumes utilizing the calculated volume fractions to arrive at local velocity conditions for the control volumes; (g) advecting the microgrid cells within the microgrid based on the calculated local velocity conditions in the control volumes such that voids and overlaps of the microgrid cells in the microgrid occur, wherein whether voids and overlaps are present is calculated using a product of the unique identifiers; (h) reallocating the microgrid cells so that only one material is in each microgrid cell to effectively conserve mass and satisfy local fluid fraction gradient values; and (i) repeating steps (e)-(h) until the simulation is complete.

Amended Claim 8 recites a method for determining whether overlapping cells and voids are present in a grid of a fluid dynamics computation comprising: assigning unique identifiers to cells located in a grid, the unique identifiers being associated with respective fluid materials; advecting the cells within a grid based on local velocity conditions such that some of the cells overlap one another in the grid and voids are created in the grid; and calculating whether overlapping cells and voids are present in the grid using a product of the unique identifiers of each of the cells located at a particular microgrid location.

The Examiner asserts that Rudman teaches "assigning a unique identifier to each of the N materials and to the microgrid cells", referring to page 359, equation 2, of Rudman. (See Page 5 of the Office Action). The Examiner further asserts that Rudman teaches

"calculating the presence of overlapping cells and voids in the grid by taking a combination of the unique identifiers of each of the cells located at a particular microgrid location", referring to page 358, paragraph 1; page 359, paragraph 1; and page 360, last paragraph, of Rudman. (See Page 6 of the Office Action).

Applicants respectfully submit that none of page 358, paragraph 1; page 359, paragraph 1; and page 360, last paragraph, of Rudman teach calculating whether voids and overlaps are present using a product of the unique identifiers, according to claim 1. More particularly, page 359, equation 2, of Rudman is the second of the four scaled equations of motion disclosed by Rudman, rather than a disclosure of assigning a unique identifier to each of the N materials and to the microgrid cells, according to claim 1.

As noted in MPEP § 2131, "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987).

Applicants respectfully submit that none of claims 1, 4, and 8 is anticipated by Rudman as each and every element as set forth in the claims is not found in Rudman. Specifically, Rudman does not disclose "assigning a unique identifier to each of the N materials and to the microgrid cells" or "advecting the microgrid cells within the microgrid based on the calculated local velocity conditions in the control volumes such that voids and overlaps of the microgrid cells in the microgrid occur, *wherein whether voids and overlaps are present is calculated using a product of the unique identifiers*", as recited in claim 1. Claim 4 is ultimately dependent upon claim 1. Similarly, Rudman does not disclose or "assigning unique identifiers to cells located in a grid, the unique identifiers being associated with respective fluid materials" or "calculating whether overlapping cells and voids are present in the grid using a product of the unique identifiers of each of the cells located at a particular microgrid location", as recited in claim 8.

Accordingly, withdrawal of the rejection of Claims 1, 4, and 8 under 35 U.S.C. § 102(b) as allegedly anticipated by Rudman is respectfully requested.

Claim Rejections Under 35 U.S.C. § 103

- I -

Claims 2, 3, and 9 stand rejected under 35 U.S.C. § 103(a) as allegedly unpatentable over Rudman, and further in view of Official Notice taken. Applicants respectfully disagree with the rejection; therefore, this rejection is respectfully traversed.

Claims 2 and 3 are dependent on claim 1, and claim 9 is dependent on claim 8. Accordingly, Applicants respectfully submit that Claims 2, 3, and 9 are patentable over Rudman for at least the reasons noted above in the discussion of the rejection of Claims 1, 4, and 8 under 35 U.S.C. § 102(b) as allegedly anticipated by Rudman.

However, Applicants further note that the Examiner acknowledges that Rudman does not disclose that the unique identifiers are prime numbers or numbers generated by an Eulerian quadratic number generator. The Examiner argues, "Applicant has not disclosed that the particular features provide an advantage, are used for a particular purpose, or solve a state problem, **as currently claimed**. It may appear the Specification discloses a specific purpose for the labeling of the items associated therewith." (Emphasis in Original; Office Action at Page 7).

Applicants respectfully submit that no limitations appearing in the specification but not recited in the claim are being read into the claim. The limitations at issue, which are currently recited in the claims, are that the unique identifiers are prime numbers or numbers generated by an Eulerian quadratic number generator. As noted above, the Examiner has acknowledged that Rudman does not disclose these limitations. As further noted above, and by the Examiner, the specification discloses a specific purpose for the unique identifiers being prime numbers or numbers generated by an Eulerian quadratic number generator. Applicants respectfully submit that the specific purpose for the unique identifiers being prime numbers or numbers generated by an Eulerian quadratic number generator is not, and need not be, read into the claims.

Accordingly, withdrawal of the rejection of Claims 2, 3, and 9 under 35 U.S.C. § 103(a) as allegedly unpatentable over Rudman, and further in view of Official Notice taken, is respectfully requested.

- II -

Claims 5-7 stand rejected under 35 U.S.C. § 103(a) as allegedly unpatentable over Rudman, and further in view of Rider's "Reconstructing Volume Tracking" ("Rider"). Applicants respectfully disagree with the rejection; therefore, this rejection is respectfully traversed.

Rider is cited as disclosing: the number N of materials tracked is at least 3 , the number N of materials tracked is at least 4, and the interfaces between the N materials are tracked by the location of the microgrid cells containing different fluid materials.

Assuming arguendo that there is some suggestion or motivation to combine Rudman and Rider and a reasonable expectation of success in combining Rudman and Rider, Applicants respectfully submit that the proposed combination of Rudman and Rider still fails to establish a *prima facie* case of obviousness at least because Rider fails to cure the deficiencies of Rudman noted above in the discussion of the rejection of Claims 1, 4, and 8 under 35 U.S.C. § 102(b) as allegedly anticipated by Rudman.

Accordingly, withdrawal of the rejection of Claims 5-7 under 35 U.S.C. § 103(a) as allegedly unpatentable over Rudman, and further in view of Rider, is respectfully requested.

- III -

Claim 10 stands rejected under 35 U.S.C. § 103(a) as allegedly unpatentable over Rudman, and further in view of Strain's "A Fast Modular Semi-Lagrangian Method for Moving Interfaces" ("Strain"). Applicants respectfully disagree with the rejection; therefore, this rejection is respectfully traversed.

Strain is cited as disclosing that modular arithmetic is applied to the product of the unique identifiers of overlapping cells to determine which fluid materials are present in the overlapping cells.

Assuming arguendo that there is some suggestion or motivation to combine Rudman and Strain and a reasonable expectation of success in combining Rudman and Strain, Applicants respectfully submit that the proposed combination of Rudman and Strain still fails to establish a *prima facie* case of obviousness at least because Strain fails to cure the deficiencies of Rudman noted above in the discussion of the rejection of Claims 1, 4, and 8 under 35 U.S.C. § 102(b) as allegedly anticipated by Rudman.

Accordingly, withdrawal of the rejection of Claim 10 under 35 U.S.C. § 103(a) as allegedly unpatentable over Rudman, and further in view of Strain, is respectfully requested.

Conclusion

In view of the foregoing amendments and remarks, reconsideration of the claims and allowance of the subject application is earnestly solicited.

Respectfully submitted,

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